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Safe Rural Water Supplies

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Safe Rural Water Supplies

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Safe Rural Water Supplies

HOW TO DETERMINE WATER SUPPLY SAFETY

WHAT IS A SAFE WATER SUPPLY?

A safe water supply source should be obtained from an uncontaminated water-bearing formation or from a properly located and constructed farm pond. The water should be pleasing to drink, bacteriologically and chemically safe, and delivered through a system which will keep it safe at all times. To accomplish this, the water source and system must be located and constructed to keep out surface and near-surface contamination, or be continuously treated.

PROBLEMS FROM UNSAFE WATER SUPPLIES

If water sources and systems are not properly located, constructed, and managed or of satisfactory chemical quality, they may be a human health hazard. Organisms causing bacterial diseases such as diarrhea, dysentery, typhoid fever, leptospirosis, and brucellosis and virus infections such as infectious hepatitis can be transmitted by unsafe water.

A high total chemical content is often objectionable because of laxative effects or nuisances such as color, taste, and odor. Excessive amounts of specific chemicals—iron, manganese, nitrate, sodium, sulfate, for example—are either a health problem or a nuisance.

Problems can also result from the use of unsafe water in processing and preparing food products for human consumption.

HOW WATER SUPPLIES BECOME CONTAMINATED

Wells and springs are a direct opening into a water-bearing formation. An improperly located and constructed well or spring can serve as a port-of-entry for surface and near-surface drainage of all kinds, bacteria, viruses, insects, small animals, and other contaminants. Ponds are continuously exposed to contaminants. One should understand some of the many ways water sources and systems become contaminated. It is also necessary to know the sanitary requirements of water source and system location and construction.

Surface Contamination

Surface contamination usually enters a well through openings in the pump, openings in the well platform or cover, faulty sealing at the top of the casing, or drainage down the outside of an unsealed (ungrouted) casing. Hand pumps with open trough-type spouts, pumps with large openings where the pump rod enters the pump top, or power pumps improperly mount-

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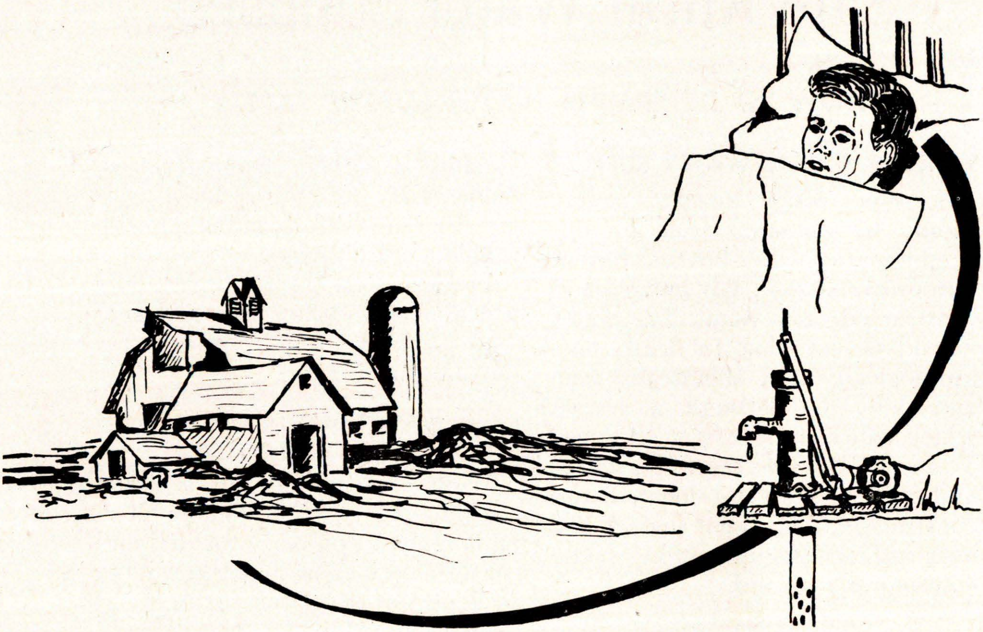


Figure 1. Improperly located or constructed water sources may be a health hazard.

ed over the well will permit entrance of contamination. Cracks or openings in well platforms (covers) allow pump waste water, surface drainage, insects, small animals, and filth carried by shoes to enter the source. Improperly sealed or grouted well casings also permit entry of contamination. Refer to figures 3, 4, 5, and 6. Storage reservoirs and springs with unsealed access manholes, unscreened overflow pipes, or unprotected vents are subject to surface contamination.

Near-Surface Contamination

Near-surface contamination is caused by seepage into the water source at some point below the ground surface. It may be due to a porous or creviced soil formation or result from failure of a well casing or a storage reservoir wall. Contaminated near-surface water may be subject to some filtering action. The effectiveness of the filtering action will vary greatly, depending upon the kind of earth material through which the water passes. **Never accept naturally occurring filtration of ground water as a substitute for safe water source location and construction.**

Synthetic detergents (syndets) are a rather recent example of a potential chemical near-surface contaminant and emphasize the need for proper water source location and construction. Syndets are not normally present in groundwater, but originate from sewage or waste water discharges into the ground. In addition, syndets are not "filtered" in passing through soils. When private wells and sewage disposal systems are (1) improperly located with respect to each other, (2) situated in a small area, or (3) inadequately constructed, the appearance of detergent foaming or sudsing in well water is an indication of near-surface sewage contamination.

Cross-Connections and Back-Siphonage

Cross-connections and back-siphonage may also contaminate a water supply system. A cross-connection is a piping arrangement whereby water from more than one source may enter a water distribution or home plumbing system. **Never cross-connect a safe water supply system with another of unsafe, or unknown quality.** If it is necessary to use an unsafe or unknown quality water for irrigation, fire protection, or other special purposes, use a separate pumping and distribution system.

Back-siphonage means drawing polluted water from a plumbing fixture into a water supply line. This may happen on an improperly constructed or installed plumbing fixture when pressure on the water supply line is lowered because of undersized pipe or a break in the line. Four common examples of back-siphonage are shown in figure 2.

Plumbing fixtures on the farm or ranch and in the rural home should be installed according to the National Plumbing Code.

SAMPLING AND TESTING OF WATER SUPPLIES

Private water supplies are sampled for bacteriological and/or chemical tests. Bacteriological or purity tests determine whether water is satisfactory for human consumption. Chemical or mineral testing may concern water to be used for (1) human consumption, (2) animal consumption, (3) irrigation of lawns, gardens, and household plants, and (4) irrigation of crops.

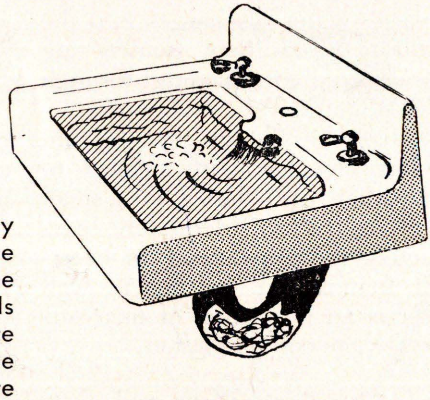
Human Consumption

Private water supplies to be tested for **human consumption** must be sampled in special bottles obtained from the State Department of Health, Pierre, or the Pennington County Health Department, Rapid City (Pennington County only). No charge is made for Health Department testing.

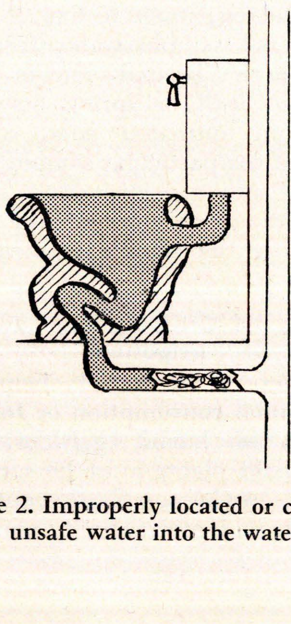
Do not sample water from an improperly located and/or constructed well or spring or water from an untreated pond source. Even if the particular sample taken should prove "satisfactory," contamination can enter at any time; therefore the sample is meaningless.

Animal Consumption, Lawn Irrigation

Waters to be tested chemically for **animal consumption or for irrigation of lawns, gardens, and household plants** must be sampled in a clean glass or plastic container of at least 1 pint capacity and sent



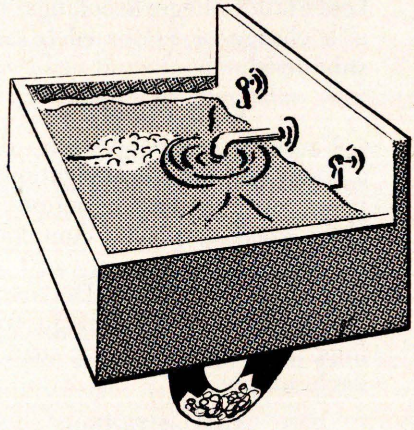
Lavatory—Where the water supply inlet is located below the rim of the basin, a vacuum occurring in the water pipe when the faucet ends are under water can cause waste water to be siphoned back into the fresh water supply. Every fixture should be designed so the faucet end is a safe distance above the highest possible water level.



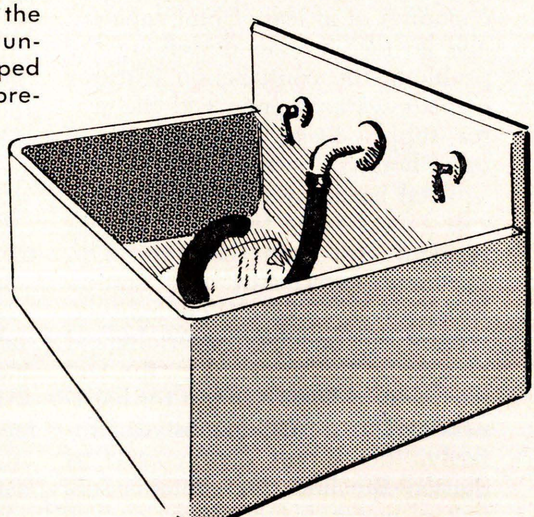
Toilet Bowl (Tank Type)—A vacuum in the water supply pipe can back siphon polluted water from the tank into the water supply system. Where a stoppage in some toilet bowls occurs, it is possible with a force pump (plumber's friend) to force polluted water from the bowl into the tank.

Figure 2. Improperly located or constructed plumbing fixtures may allow entry of unsafe water into the water supply system (continued on next page).

Submerged Inlets—Many commercial sinks such as used on soda fountains, tanks, and vats for industrial uses have submerged water supply inlets. This is also true of laundry machines, and other appliances. Such inlets permit an easy back-siphonage of polluted water into water supply lines when a vacuum occurs.



Spray Hose in Sink—If there is a vacuum created in the water supply line while the nozzle end of a dish spraying hose is submerged in the water in the sink, then polluted water can be siphoned from the sink into the pure water supply unless the supply fixture is equipped with some type of backflow prevention device.



to Station Biochemistry, South Dakota State College, Brookings. There is a charge of $1 for each sample submitted.

Crop Irrigation

Farmers or ranchers who desire a water test for **crop irrigation** purposes must collect a sample in a clean glass or plastic container of at least 1 quart capacity and transmit to the Agronomy Department, South Dakota State College, Brookings. A charge of $1 is made for each sample.

Special Testing

Special water tests are performed by the State Department of Health, Pierre, on request for problems of suspected human health significance—taste, odor, visible foreign material. For problems concerning animal or general use, the tests are made by Station Biochemistry, South Dakota State College, Brookings. Collect special samples in a clean glass or plastic container of at least 1 pint capacity and enclose a letter describing the problem, the construction features of your water supply, and the water supply location in respect to other home or farm facilities.

Total hardness and iron tests are run as a service to South Dakota residents by both the State Department of Health and Station Biochemistry. There is enough water in the special bacteriological sample bottle furnished by the Department of Health to test for hardness and/or iron, if requested. Similarly, the 1 pint sample sent to Station Biochemistry contains sufficient water for hardness and/or iron tests in addition to the water needed for animal or irrigation use analysis.

WATER SUPPLY BACTERIOLOGICAL AND CHEMICAL STANDARDS

Bacteriological

Water samples submitted to the Department of Health for bacteriological testing are analysed for coliform bacteria, which if present indicate that bacteria which cause disease may also be present. The coliform bacteria is an organism of fecal origin and its presence indicates that surface or near-surface contamination originating in soil or in the intestines of warm-blooded animals has entered the water supply—or the water sample, if the sample was not properly collected.

Bacteriological water samples are not tested for specific disease bacteria or for viruses. A bacteriological water sample is either "Satisfactory at the Time of Sampling" or "Unsafe." A "Satisfactory" test result from an improperly constructed water source or an untreated pond source is meaningless and will only create a false sense of security.

Chemical

Chemical analyses of private water supply interest include total solids (conductivity), pH, alkalinity, hardness, iron and manganese, sodium, nitrate, fluoride, chloride, and sulfate.

Total solids is simply a measurement of the total chemical content of a water. The conductivity test is a short method for approximation of total solids, as the standard total solids test is detailed and time-consuming. Total solids is only of general interest with regard to human water consumption; however, the test is used in conjunction with other analyses for classification of water used for animals or irrigation.

The pH of a water indicates whether it is acid or alkaline. The range of pH measurement is from 0 to 14. A pH of less than 7.0 indicates an acid water; a pH of 7.0 is neutral, and a pH greater than 7.0 indicates an alkaline water. The pH of naturally occurring waters in South Dakota varies from 6.6 to 9.0, slightly acid to quite alkaline; however, most waters are in the slightly alkaline range of 7.2 to 8.0.

The alkalinity test, along with the pH and hardness analyses, is used by the laboratory chemist to estimate the approximate concentration of the many chemicals which make up a natural water without actually carrying out the many tests. Thus, the test is a laboratory tool and not of general interest.

Hardness is defined as the soap-consuming capacity of water; it consists of calcium and magnesium in combination with bicarbonates and sulfates. "Temporary" hardness is made up of calcium and magnesium bicarbonates, while calcium and magnesium sulfates are commonly termed "permanent" hardness. Hardness in water is a nuisance. Water with a hardness of 25 to 50 grains per gallon (425 to 850 parts per million) is average for South Dakota.

Iron and manganese are nuisance chemicals, as they cause deposits in water lines and leave stains on plumbing fixtures and light-colored cloth. Iron causes yellow, red, or reddish-brown deposits and stains. Manganese deposits and stains are black or grey.

The chemical, **sodium,** may be a health problem and also of concern to irrigators. Persons on a low salt diet for medical reasons must know the sodium content of their potable water in order to properly control their total sodium intake under the supervision of their personal physician. As previously mentioned, the sodium test is used in conjunction with the total solids analysis to determine whether a water is fit for irrigation use.

Presence of **nitrate** indicates that surface or near-surface contamination containing organic matter has entered the water source. Water containing nitrate as nitrogen in excess of 10 parts per million should not be used for infant humans 6 months of age or less, and water with a nitrate content of over 300 parts per million is unsatisfactory for livestock use.

Fluoride is only of human dental health significance. A proper amount of fluoride in a drinking water (0.9 - 1.7 parts per million) has been shown to reduce tooth decay in children. A high fluoride content has been found to cause pitting and staining of tooth enamel, but does reduce tooth decay. A low fluoride content neither protects nor damages teeth.

Chloride produces a salty taste in water. It is not too common in South Dakota, but does occur in some artesian wells.

A high **sulfate** content produces a bitter taste in water and may have a laxative effect on persons unaccustomed to the water.

HOW TO DEVELOP A SAFE WATER SOURCE

WELLS

Location in Relation to Sources of Pollution

Observe the following minimum horizontal distances between wells and pollution sources to avoid contamination of the well water.

Cesspool (receiving raw sewage) .... 150 ft.*

Seepage (leaching) pit (receiving settled sewage, laundry wastes, or kitchen wastes), subsurface sewage disposal field, sewage filter bed, or poorly drained barnyard .... 100 ft.*

Septic tank, pit toilet or privy, sewer of tightly jointed tile or equivalent material, or sewer-connected foundation drain .. 50 ft.*

Barnyard with good drainage, barn gutter, animal pen or stall with concrete floor, or farm silo .... 25 ft.*

Sewer of cast iron with leaded or flanged joints .... 10 ft.*

Pumphouse floor drain of cast iron with leaded or flanged joints .... 2 ft.*

Location in Relation to Buildings

When a well is located adjacent to a building, a vertical projection of the center line of the well should clear any overhead projections of the building (such as eaves) by at least 5 feet. Wells should be easily accessible for cleaning, repair, treatment, and inspection. Well heads and well casing openings should not be in pits, rooms, or spaces that are below the established ground surface.

*For wells of less than 100 foot depth in very porous soils, increase the distance by at least 50%.

Other Location Precautions

The well top should be at a higher elevation than any source of contamination. Well casings should extend above the highest known high water mark in areas that are subject to flooding. Wells should not be placed in soil formations that are creviced, fractured, shattered, or otherwise channeled unless special precautions are taken to seal crevices or fractures.

Dug or Bored Well Construction

Dug or bored wells are usually hand excavated and quite shallow. They are the least desirable from a sanitation standpoint. Figure 3 shows proper construction of a dug well. The seal around the pump base and the lip on the manhole cover are very important in preventing contamination from the surface. The puddled concrete or grout collar around the casing serves to prevent near-surface contamination. Grout is the more desirable. The mix should be 6 gallons of water to 1 bag of cement. (If puddled concrete is used, a mix of 1:4 with a maximum sand size of one-fourth inch is satisfactory.) The mix should be wet enough to flow easily into the space between the casing and earth wall.

Driven Well Construction

Driven wells may be used in areas where the water-bearing formations are near the surface. They consist of a pipe fitted with a driving point and screen that are

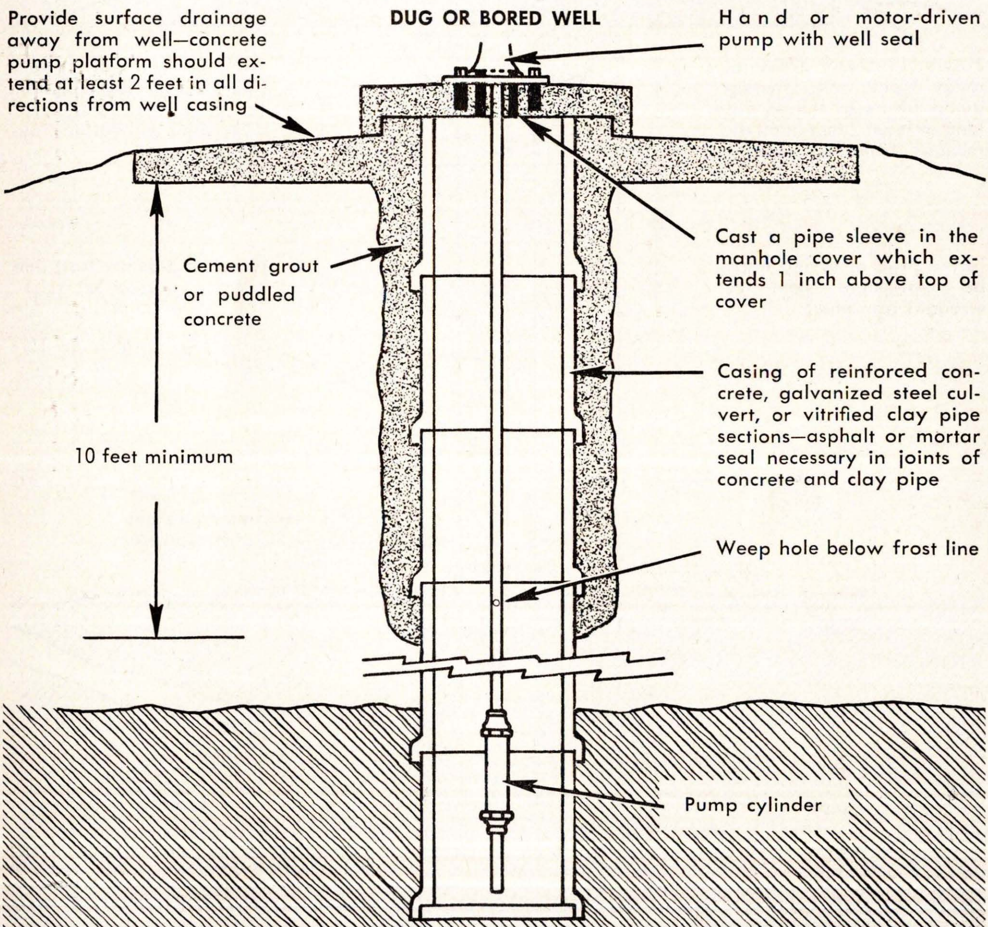


Figure 3. In dug or bored wells, seal the platform and the area where the casing enters the dug or bored hole.

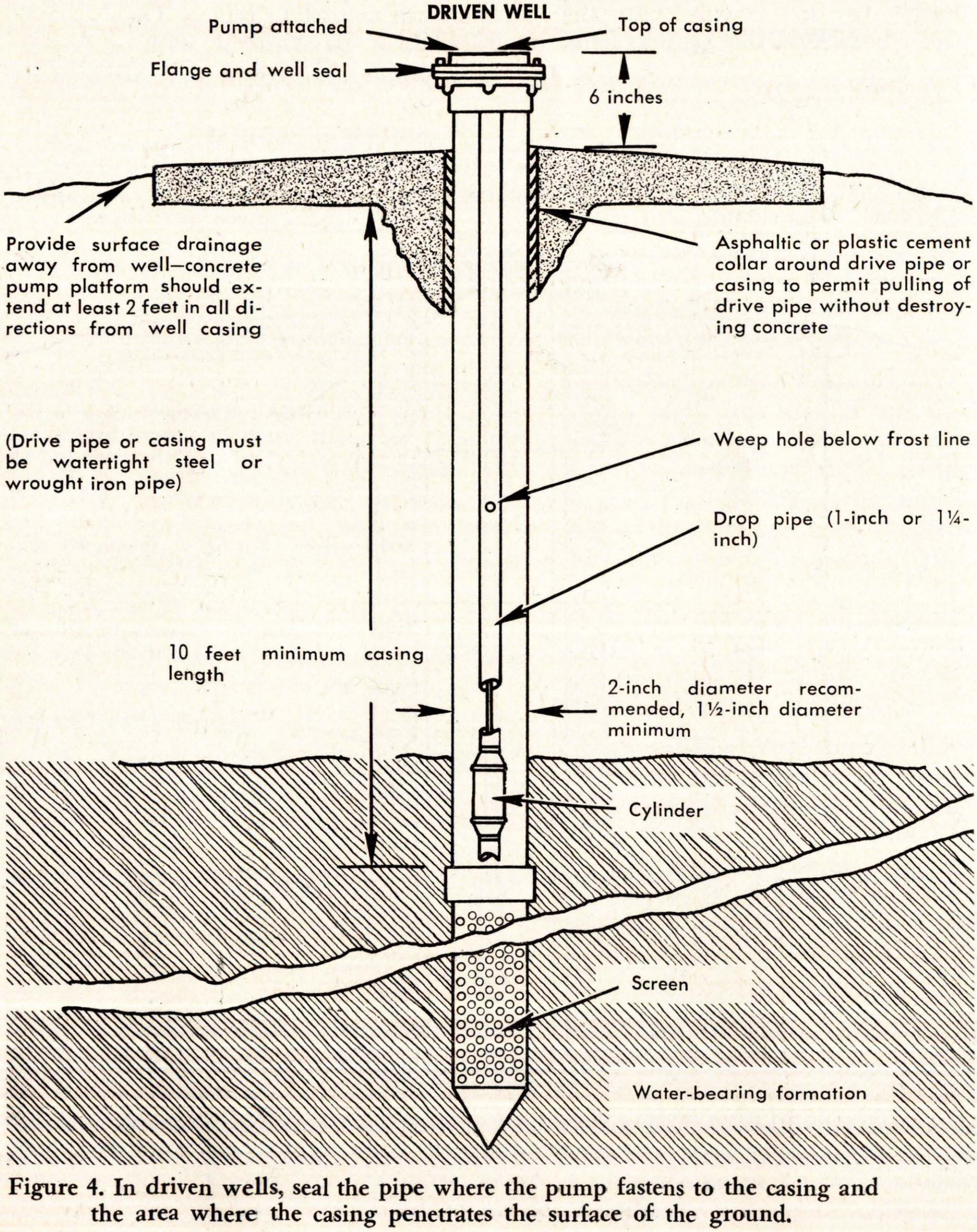


Figure 4. In driven wells, seal the pipe where the pump fastens to the casing and the area where the casing penetrates the surface of the ground.

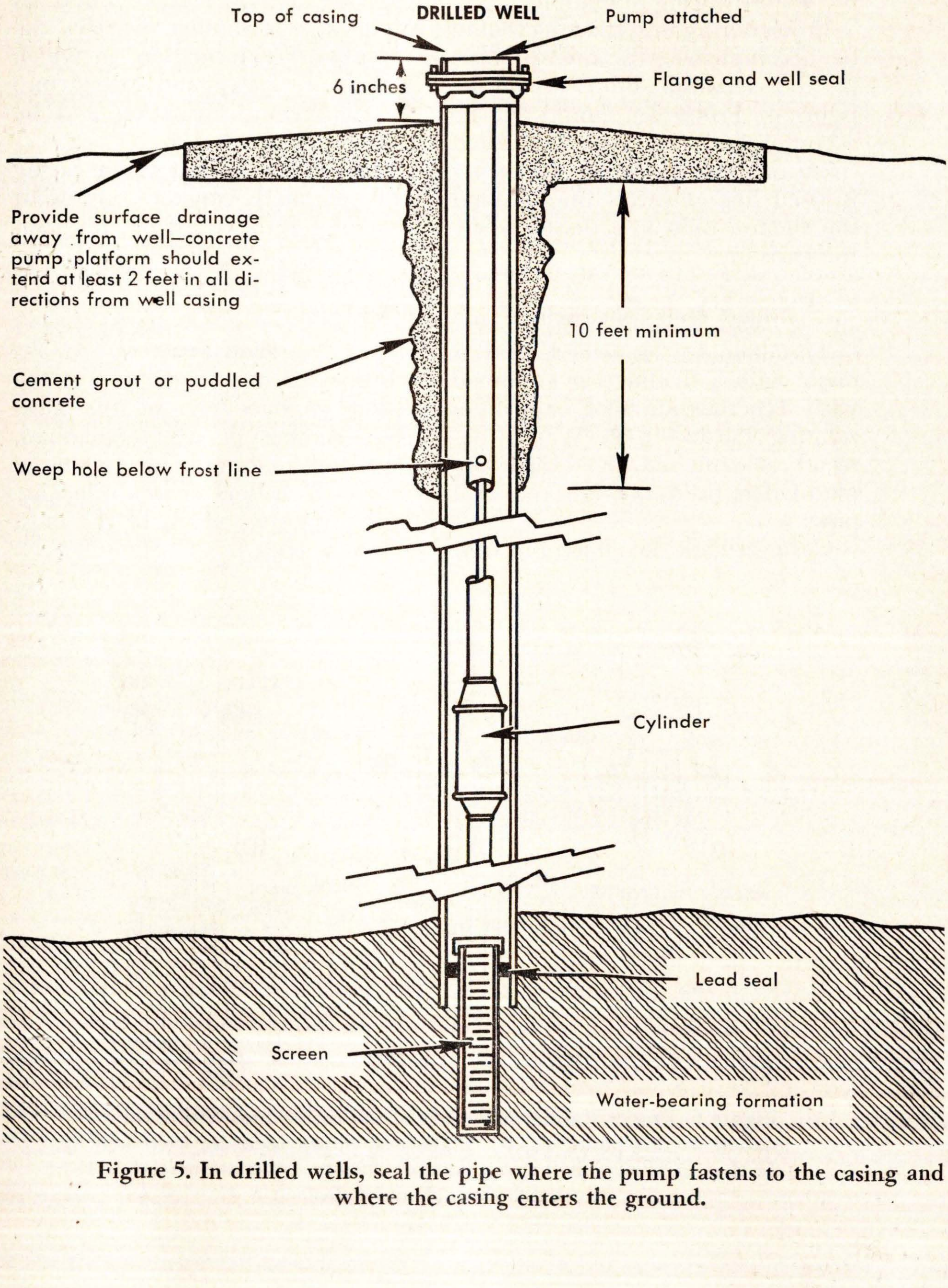


Figure 5. In drilled wells, seal the pipe where the pump fastens to the casing and where the casing enters the ground.

driven into the ground to the depth necessary to put the screen into the water-bearing formation.

Protection against freezing should be accomplished by a weep hole in the separate drop pipe (see figure 4). Protection should not be accomplished by the so called "frost pit" method where no casing is used and a pit is dug around the suction pipe to a depth below the frost line.

Drilled Well Construction

The hole for a drilled well is made with a drilling rig equipped with a percussion tool or with a rotating cutting tool. Waste material is removed by circulating mud-laden fluid through the drill pipe.

Casing should be of steel or new wrought iron with welded or threaded joints. Extend the casing to the water-bearing formation unless an impervious formation overlays the water-bearing formation, in which case the casing should extend into the impervious formation and be sealed with grout.

Seal the upper part of the casing with puddled concrete or grout (see dug or bored wells for concrete and grout specifications). Figure 5 shows proper construction of a drilled well.

Well Seals

Proper sealing of the top of the casing removes one of the most likely sources of well contamination. Well seals may be purchased from well drillers or made locally. Figure 6 shows seven of the most common types.

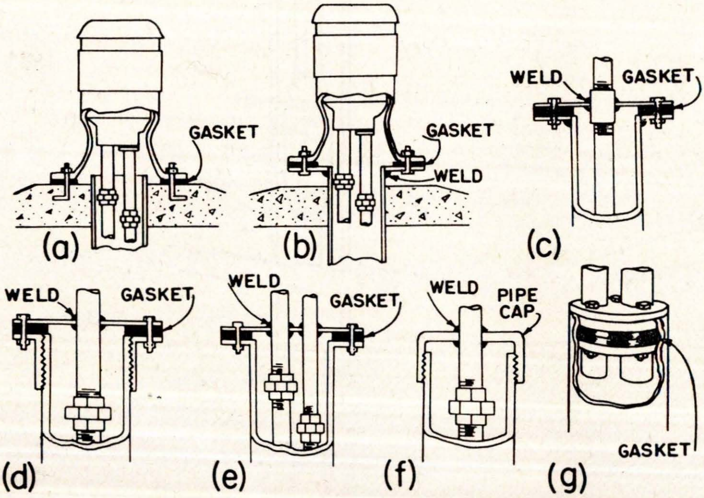


Figure 6. Proper sealing of the top of the casing prevents contamination at this point. (a, b) Tight-base pump used for well seal. (c, d, e, f) Well seals that can be made locally. (g) Commercial seal available through most dealers.

Disinfecting Wells

Wells should be disinfected following original construction; after repair work such as installing a new cover, new pump, pump packing, or pipes; or if a well is reconnected after being out of use for a period of time. A flooded well also requires disinfection.

The following tables show the amount and kind of disinfectants that may be used. Table 1 is for large diameter wells (dug or bored). Table 2 is for small diameter wells (drilled or driven). Following is an example of how to use the tables.

Assume that you have a 6-foot diameter dug well (line 1, column 5 of table 1). Assume that your well has 10 feet of water in it (line 3). If you wish to use a regular household bleach as a disinfectant, look on the label to see if it is a 3% bleach or a 5.25% bleach. Assuming that it is 3%, you would use the amount shown in line 4, column 5, or 6 cups per foot of water in the well—6 cups x 10 feet=60 cups

Table 1. Chlorine Dosage for Disinfection of Circular Wells, 2-10 Feet in Diameter

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
1. Diameter of well	2 ft.	3 ft.	4 ft.	6 ft.	8 ft.	10 ft.
2. Gallons of water for every 1 foot of water in well	24 gal.	53 gal.	94 gal.	212 gal.	376 gal.	588 gal.
3. Number of feet of water in your well						
4. Amount of 3% liquid bleach to use for every foot of water in your well	⅔ cup*	1½ cups	2⅝ cups	6 cups	10½ cups	16½ cups
5. Amount of 5.25% liquid bleach to use for every foot of water in your well	⅜ cup	⅞ cup	1½ cups	3⅜ cups	6 cups	9⅜ cups
6. Amount of 25% chlorinated lime powder to use for every foot of water in your well	⅛ cup	¼ cup	⅜ cup	¾ cup	1¼ cups	2 cups
7. Amount of 70% calcium hypochlorite powder to use for every foot of water in your well	1/32 cup	1/16 cup	⅛ cup	¼ cup	½ cup	¾ cup

*1 cup=8 oz.=½ pt.

Table 2. Chlorine Dosage for Disinfection of Circular Wells, 2-12 Inches Diameter

1. Diameter of well	2 and 3 in.	4 and 6 in.	8 and 10 in.	12 in.
2. Gallons of water per 10 feet of water in well	2 and 4 gal.	7 and 15 gal.	26 and 41 gal.	60 gal.
3. Number of feet of water in your well				
4. Amount of 3% liquid bleach to use for every 10 feet of water in your well	⅛ cup*	½ cup	1⅛ cup	1⅝ cup
5. Amount of 5.25% liquid bleach to use for every 10 feet of water in your well	1/16 cup	¼ cup	⅔ cup	1 cup
6. Amount of 25% chlorinated lime powder to use for every 10 feet of water in your well	-----	1/16 cup	⅛ cup	¼ cup
7. Amount of 70% calcium hypochlorite powder to use for every 10 feet of water in your well	-----	-----	-----	⅛ cup

*1 cup=8 oz.=½ pt.

to treat the well. If you use 5.25% bleach, chlorinated lime, or hypochlorite powder, use the amounts shown in the appropriate line on the table.

If household bleach is used, mix the specified amount with about 3 gallons of water and pour it into the well. If chlorinated lime or hypochlorite is used, add small amounts of warm water to the powder and stir to form a smooth paste. Add 5 gallons of water and stir for about 10 minutes. Allow the solution to settle, pour off the clear liquid, and discard the settlings.

If a dug or bored well is being treated, pour the solution down the walls of the well. Agitate the water in the well by starting and quickly stopping the pump. In case of a dug well, it may be agitated by stirring. Allow the solution to remain in the well for 8 hours (or overnight), then pump it out through the entire system opening all faucets, sillcocks, and similar fittings. Allow water to run until all taste and odor of chlorine has disappeared.

SPRINGS AND STORAGE RESERVOIRS

Spring Location and Construction

The location of a spring with relation to sources of pollution should be the same as that previously listed for wells. Considerable construction is required in developing or improving a spring as a safe source of water for human consumption. The following steps should be taken:

1. Prevent surface water contamination by diverting natural streams away from spring site and by not allowing flood waters to reach the spring.

2. Allow spring water to collect in a box constructed of waterproof materials (see figure 7).

3. Provide for draining of box if at all possible to permit cleaning and disinfection.

4. Provide for overflow from the box.

5. Place screen around discharge pipe.

These features are shown in figure 7 as an example of how a spring should be protected. Other

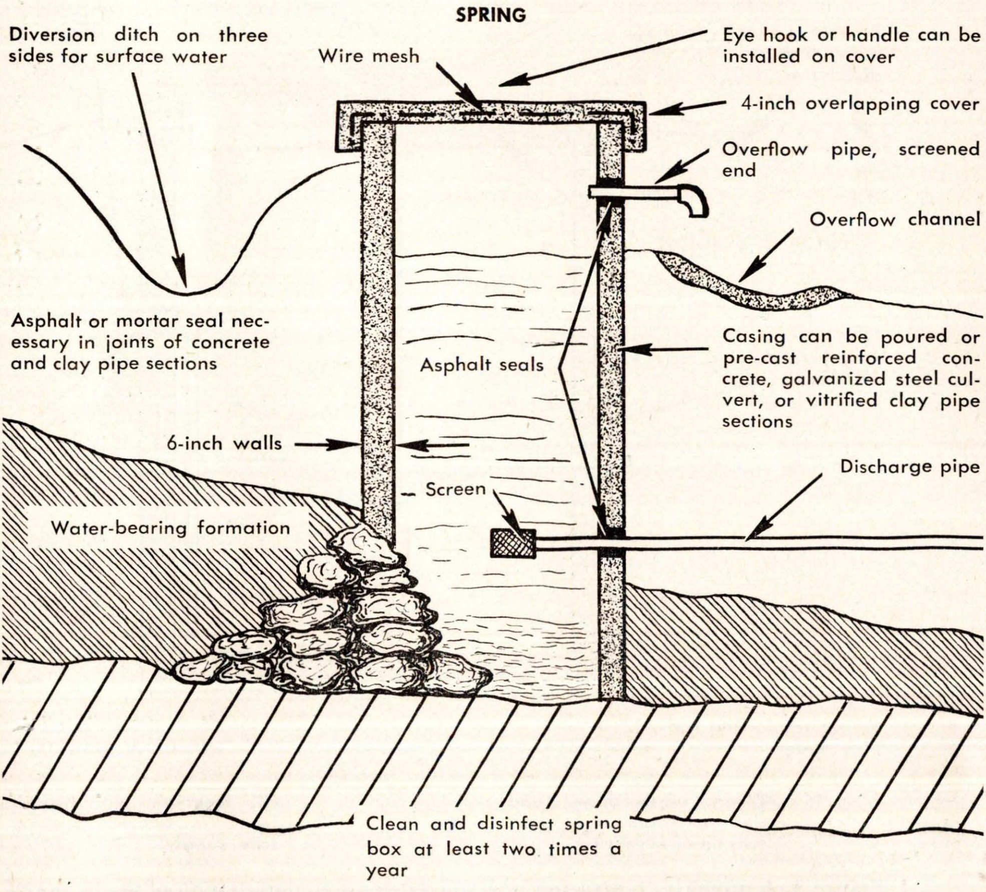


Figure 7. Developing a spring as a safe water supply requires careful construction.

arrangements are possible as long as they will accomplish the suggested steps given above.

Storage Reservoir Location and Construction

A reservoir to be used as a domestic water supply must be built to prevent contamination of stored water. The following steps should be taken:

1. Provide a means for diverting surface water away from the reservoir.
2. Make the reservoir watertight and completely closed.
3. Provide an overlapping manhole cover over a raised ring.

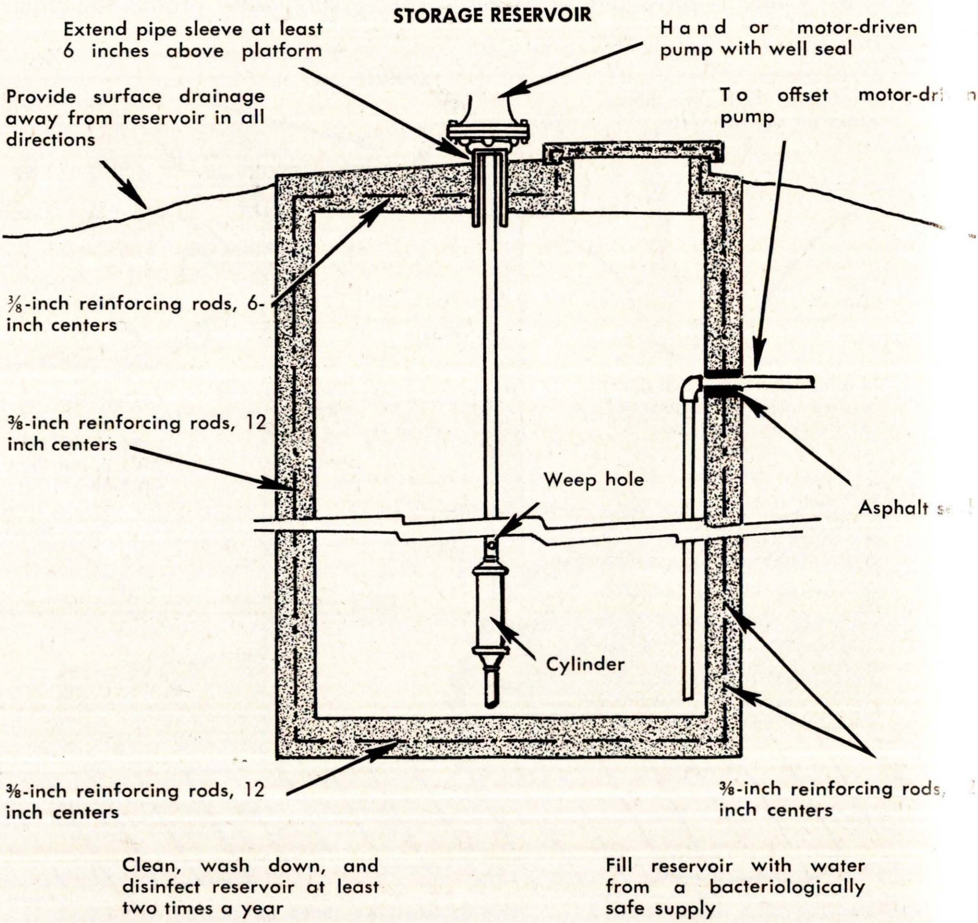


Figure 8. A properly constructed reservoir prevents contamination of water stored in it.

4. Construct reservoir of reinforced concrete or steel. Plastered brick reservoirs are not recommended.

The purity of water in a reservoir is no better than the water entering it. Roof drainage should not be discharged to a reservoir containing water to be used for human consumption. Water for a reservoir should be obtained from a known bacteriologically safe supply, such as a municipal system or a properly located and constructed local source.

Figure 8 shows a cross section of a properly constructed reservoir.

Disinfecting Springs and Storage Reservoirs

Springs and storage reservoirs should be disinfected following (1) original construction, (2) any repair work, (3) a period of nonuse or (4) suspected contact with flood waters. It is also recommended that spring boxes and storage reservoirs be drained, washed down, and disinfected two times a year—once in the spring and once in the fall. The procedure for proper disinfection of springs and storage reservoirs is the same as previously outlined for dug or bored wells. Prepare the required chlorine solution in accordance with table 3.

PONDS

Location of the Pond

Preventing contamination should receive first consideration when locating a farm pond that is to be used for a household water supply. Dysentery, diarrhea, typhoid fever, infectious hepatitis, and other intestinal infections are easily transmitted by water that has been contaminated by human or animal wastes.

From the standpoint of cost and convenient maintenance, the pond should be as near the farmstead as

Table 3. Chlorine Required for Disinfection of Springs and Reservoirs

Capacity of spring or reservoir (gal.)	Water necessary for preparing chlorine solution (gal.)	Household bleach (5.25% chlorine)	Chlorinated lime (25% chlorine)	Calcium hypochlorite (70% chlorine)
50	5	¾ cup	1½ oz.	½ oz.
100	5	1½ cups	3 oz.	1 oz.
300	5	4½ cups	9 oz.	3 oz.
500	5	7½ cups	15 oz.	5 oz.
1,000	10	15 cups (1 gal.)	1 lb. 14 oz.	11 oz.
2,000	15	30 cups (2 gal.)	3 lbs. 12 oz.	1 lb. 5 oz.
3,000*	20	------	5 lbs. 10 oz.	2 lbs. 0 oz.
5,000*	50	------	9 lbs. 6 oz.	3 lbs. 6 oz.
10,000*	100	------	18 lbs. 12 oz.	6 lbs. 12 oz.

*Large units may be disinfected by thoroughly washing the walls and floor with a 200 parts per million chlorine solution.

possible and at a higher elevation.

Water draining off ungrazed meadow or woodlands provides the least probable contamination. Never allow water draining from barnyards or other points of high contamination to flow into the pond. Do not use ponds used for domestic water supply for swimming. Fence out livestock.

Size of the Pond

Pond size will depend on whether the water source is for household use only or household and livestock use. Table 4 lists some typical pond sizes needed for various use demands. The table is based on an assumed annual water loss of 50% by evaporation and seepage. The table also assumes that the pond will fill at least once each year. If a 2 year supply is desired as a safety factor, multiply all values by 2.

Table 4. Typical Pond Sizes to Supply Various Needs

User*	Actual annual needs* (gal.)	Acre feet required† (Incl. evaporation, and seepage loss)
Family of 6	109,500	.68
Family of 4 40 dairy cattle 100 hogs	584,000	3.6
Family of 5 100 beef cattle 500 chickens 200 hogs 150 sheep	949,000	5.8

*Based on average daily consumption of 50 gallons/person/day, 25 gallons/dairy cow/day, 12 gallons/beef cow/day, 4 gallons/hog/day, 10 gallons/100 chickens/day, 2 gallons/sheep /day.

†Acre foot is 1 acre of water 1 foot deep or 326,000 gallons.

The pond should have a minimum depth of 12 feet to insure an adequate water supply during the winter months when the pond is frozen over. If cultivated land is in the pond's watershed, increase minimum depths by at least 25% to allow for silt storage. This removes the necessity for dredging every few years.

Obtain engineering assistance in determining cross sectional area, possible depth, surface area, and capacity of the proposed pond. After computing capacity of the pond, check it against needs as computed by the method shown in table 4.

Table 5 lists some typical sizes and capacities that may serve as an indication of size-capacity relationship.

Table 5. Typical Pond Sizes and Capacities (Banks with side slopes 3 to 1)

Depth of water at spillway level (ft.)	Av. diameter at spillway level (ft.)	Diameter at bottom in ft.	Capacity of pond in gal.
12	100	28	319,000
12	150	78	946,000
16	150	54	1,049,000

Size of Drainage Area

The drainage area (watershed) needed to supply desired quantities is dependent on rainfall, soil types, vegetative cover, topography, land use, and presence or absence of streams and springs. Since all these factors vary widely in South Dakota, no attempt is made to set up per acre water yields of drainage areas. County Extension agents or Soil Conservation Service technicians working in the area should be asked to compute the yield for the exact area in question.

HOW TO PROVIDE SAFE WATER TREATMENT

REASONS FOR TREATMENT

Contaminants that may make water unpleasing for normal consumption on the farm, ranch, or home are either physical, chemical, or biological. Physical properties include temperature, turbidity (visible dirt), color, odor, and taste. Water chemicals have been discussed in a previous section. Biological contaminants include bacteria, algae, worms, small animals, and insects.

TREATMENT FOR PHYSICAL PROBLEMS

Temperature of well water has a usual range of 45 to 55 degrees Fahrenheit. Many artesian waters in this state, however, are in the lukewarm temperature range of 70 to 90 degrees. A few recently developed deep artesian wells in western South Dakota have water temperatures of 120 to 150 degrees Fahrenheit. Hot or warm water can be used for all purposes except drinking with little or no cooling. Drinking water can, of course, be refrigerated.

Color, odor, taste, and turbidity are primarily problems of farm pond water treatment. Color and turbidity are due to surface runoff into the pond. Tastes and odors are usually caused by nuisance biological growths (algae) but may result from organic matter brought in by surface runoff. Farm pond water treatment involves a combination of chemical treatment and filtration together with pumps and tanks. A typical system might consist of the following:

1. Raw water intake in pond should be below water surface, off pond bottom, and away from shoreline.

2. Raw water pump.

3. Reservoir with a capacity of 4 to 6 hours at design flow. Chlorinate the water for disinfection and treat with alum for removal of turbidity (dirt). Following chemical treatment allow the water to settle 4 to 6 hours. Two ounces of 70% chlorine powder, 5 ounces of chlorinated lime or 1½ pints of 5% household bleach per 1,000 gallons of water is suggested for proper chlorination of water in the reservoir. Make a chlorine residual test and use sufficient chlorine dosage to produce a residual of 1 part per million in the water after settling. Convenient test kits are available for these tests. The suggested alum dosage is a half pound per 1,000 gallons of water in the reservoir. Thorough mixing of the chemical is

important. More alum may have to be used in the spring and after sudden runoff. Water which is clear and colorless after 4 to 6 hours of settling indicates a proper dosage of alum.

4. Pressure water pump of design flow capacity.

5. Pressure sand filter of standard commercial manufacture. Provide 1 square foot of filter surface area for each 2 gallons per minute design flow.

6. Pressure activated carbon filter of standard commercial manufacture, which provides 1 square foot of filter surface area for each 2 gallons per minute design flow.

7. Pressure water tank of proper size for the demand of the farm, ranch, or home.

Farm pond water treatment units are generally available from water conditioning companies, plumbing contractors, and well drilling contractors, with assistance from their jobbers and manufacturers.

TREATMENT FOR CHEMICAL PROBLEMS

To date there are no practical or economical water treatment methods for reduction of total solids (total chemical content) or the individual minerals—sodium, nitrate, fluoride, chloride, or sulfate. Private water supply demineralizers for total solids reduction are in the research, development, and demonstration stage, but are not ready for general distribution.

Hardness reduction in water is called water softening. The home water softener is a pressure unit which usually contains the material, sodium zeolite. Hardness is caused by calcium and magnesium. When water is passed through the bed of zeolite, the sodium takes the place of (or is exchanged for) the calcium and magnesium. This process results in soft water.

The calcium and magnesium remain attached to the zeolite until the unit is regenerated. Common salt, sodium chloride, is used for regeneration. Regeneration involves another chemical exchange—the sodium in the salt takes the place of the calcium and magnesium attached to the zeolite, while the calcium and magnesium are discharged with the chloride to the sewer as a waste product.

Care should always be taken to provide complete regeneration and backwashing. Water softening with zeolite does not reduce the total solids content of a water supply. **The increase in sodium content should be of interest and concern to persons on a low-salt diet for medical reasons.**

The nuisance chemicals, iron and manganese, often occur in combination with the odorous gas, hydrogen sulfide (rotten egg odor). Proper treatment involves various combinations of aeration, chlorination, and filtration, depending on the particular water analysis. Iron and/or manganese alone can be removed in a home water softener equipped with special zeolite. Iron, manganese, and objectionable gases may be removed by commercial equipment available from your local water conditioning company, plumbing contractor, or well drilling contractor, with the assistance of their jobbers and manufacturers.

TREATMENT FOR BIOLOGICAL PROBLEMS

Biological contaminants may involve either surface or groundwater supplies. Keep biological life, such as bacteria, worms, insects, and small animals, out of wells and springs by proper location and construction. Wells or springs in porous or creviced formations may be subject to bacteriological contamination but otherwise be satisfactory. Such sources can be continuously disinfected with a chemical such as chlorine. The use of a chemical feed pump for addition of chlorine is recommended. Ultra-violet disinfection devices, methods which require the use of silver, and proposals for disinfection with "new or magic" chemicals are not recommended.

Biological matter in surface waters, except for algae, is effectively and economically removed by the farm pond treatment system previously described. Algae in farm ponds—usually green or blue-green surface growths—are best controlled by preventive measures rather then water treatment. Routinely dose a pond known to produce algae growths with copper sulfate (blue vitriol) whenever the pond water temperature is over 55 degrees Fahrenheit. Up to 4 pounds of copper sulfate per acre (minimum average pond water depth of 6 feet) can be used without affecting game fish. Spread the copper sulfate uniformly over the pond from a boat, with particular emphasis on the shallow water areas.

MISCELLANEOUS WATER TREATMENT

Common effective and economical methods of water treatment have been briefly discussed in the preceding pages. Many water treatment "special" chemicals, "miraculous" devices, and "new" methods are advertised and promoted from time to time. Some may be satisfactory for a specific problem, but all should be carefully investigated for general use. Contact the Department of Health if in doubt.

SOUTH DAKOTA STATE COLLEGE

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